the mutual actions and reactions of the parts on each other do not alter the motion of their common centre of gravity. [Newt. Princip. B. 1. Law 3. and Corol. 4.]

Hence the increaſe of power from the centrifugal force, multiplied into the augmentation of velocity thereby occaſioned, juſt equals the force neceſſary to move the water into its ſpiral direction; which correſponds with what was before deduced from a different calculus.

Note under the head *Area of the Apertures*, page 192, the reſulting equation, which, by inadvertently uſing a for 2a, &c. is $\frac{AV}{8.924\sqrt{h}}$ ſhould be $\frac{AV}{18.47\sqrt{h}}$; and, of courſe, the number 8.924, in rule 4th page 193, ſhould be 18.47; but this overſight does not affect any other part of the calculation.

Philadelphia 4th 4mo. 1793.

Wm. WARING.

N°. XXXV.

An Improvement on metalic Conductors or Lightening-rods, in a Letter to Dr. DAVID RITTENHOUSE, *Preſident of the Society, from* ROBERT PATTERSON *of Philadelphia.*

☞ *This Paper was honoured with the Magellanic Premium, by an Award, of the Society in December* 1792.

SIR,

Read Nov. 5, 1790. FROM the inſtances which now and then occur of houſes being ſtruck with lightening, that are furniſhed with metalic conductors, and the frequent

quent inſtances of theſe conductors having their tops melted off by a ſtroke of lightening, it appears that this admirable contrivance for guarding houſes againſt the dangerous effects of lightning is, in ſome degree, ſtill imperfect. Some improvement ſeems yet to be wanting at both extremities of the rod—at the upper extremity, to ſecure it againſt the accident of being melted, which renders it afterwards unfit to anſwer its original intention, viz. drawing off the electric fluid, or lightening, from the paſſing cloud, in a ſilent, imperceptible manner; for it is only *pointed* conductors that poſſeſs this property—and at the lower extremity, to afford a more ready paſſage for the fluid into the ſurrounding earth.

The firſt of theſe intentions, would, I am perſuaded, be effectually anſwered, by inſerting in the top of the rod a piece of *black-lead*, of about two inches long, taken out of a good pencil, and terminating in a fine point, projecting but a very little above the end of its metalic ſocket; ſo that, if the black-lead point ſhould happen to be broken off by any accident, of which however I think there can be but little danger, ſtill the point of the rod would be left ſharp enough to anſwer the purpoſe of a metalic conductor.

This ſubſtance is well known to be infuſible, by the greateſt heat, and hence its uſe in making crucibles; nor is it evaporable, as remarked by Cronſtedt, in his mineralogy ſect. 231, except in a ſlow calcining heat, to which it could never be expoſed on the top of a lightning-rod.

At the ſame time its power as a conductor of electricity is perhaps equal, or but little inferior, to that of any of the metals. A line drawn on a piece of paper, by a black-lead pencil will, as I have often experienced, conduct an electric exploſion ſeemingly as well as a ſimiliar

line

line of gilding would do, and that without ever looſing its conducting power, which is not the caſe with gilding.

The ſecond intention is, to facilitate the eſcape of the electric fluid, from the lower part of the rod into the ſurrounding earth. It is, in many caſes, impracticable, from the interruption of rocks or other obſtacles, to ſink the rod ſo deep as to reach moiſt earth, or any other ſubſtance which is a tolerably good conductor of electricity. Nor even if this were practicable, would it, I preſume, be alone ſufficient to anſwer the deſired intention. Iron, buried in the earth, and eſpecially in moiſt earth, will preſently contract a coat of ruſt, which will continually increaſe till the whole is converted into ruſt: but ruſt of iron, and indeed the calx of all metals, is a *non-conductor*, or at moſt but a very imperfect conductor of the electric fluid. Hence it is eaſy to ſee, that in a few years after a lightening rod has been erected, that part of it which is under ground will contribute little or nothing towards the ſafety of the building. Beſides, the ſurface of this part of the rod is *too ſmall* to afford an eaſy and copious diſcharge of the electric fluid into the ſurrounding earth, when this is but an imperfect conductor.

As a remedy for theſe defects, I would propoſe, that the part of the rod under ground be made of tin, or copper, which are far leſs liable to corroſion or ruſt, by lying under ground than iron. Or, which perhaps would anſwer the purpoſe better, let this part of the rod, of whatever metal it be made, be coated over with a thick cruſt of black-lead, previouſly formed into the conſiſtence of paſte, by being pulverized and mixed with melted ſulphur (as in the manufactury of the ordinary kind of black-lead pencils) and then applied to the rod while hot. By this means, the lower part of the rod would, I apprehend, retain its conducting powers for ages, without any diminution.

In order to increaſe the ſurface of the lower part of the conductor, let a hole or pit, of ſufficient extent, be dug as deep as convenient; and into this pit, let there be put a quantity of *charcoal*, round the lower extremity of the rod. Charcoal poſſeſſes two properties which, in a peculiar manner, fit it for anſwering the purpoſe here in view. (1) It is a very good conductor of electricity, and (2) it will undergo little or no change of property by lying ever ſo long in the earth. Thus might the ſurface of that part of the conductor, in contact with the earth, be increaſed with little trouble or expence to any extent at pleaſure; a circumſtance which every one acquainted with electrical experiments, muſt acknowledge to be of great importance to the end here propoſed.

Whither the above hints may merit a place among the communications from candidates for the annual premium, is humbly ſubmitted

By yours, &c.

PHILO FRANKLIN.

N°. XXXVI.

An eaſy and expeditious method of diſſipating the noxious Vapour commonly found in Wells and other ſubterraneous places, by EBENEZER ROBINSON, of Philadelphia.

Read Nov. 3d, 1786. AFTER various unſucceſsful trials, (a detail of which has been already communicated,) I was led to conſider, how I could convey a large quantity of freſh air, from the top to the bottom of the well; ſuppoſing that the foul would neceſſarily give way to the pure air.—With this view I procured a pair of ſmiths bellows, fixed